Atomic Energy Control Board
P.O. Box 1046
Ottawa, Canada
K1P 5S9

Commission de contrôle de l'énergie atomique
C.P. 1046
Ottawa, Canada
K1P 5S9

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RECENT DEVELOPMENTS IN THE REGULATION AND MANAGEMENT OF CANADIAN URANIUM TAILINGS

by

K. Bragg, C. Potter and
A. James

Atomic Energy Control Board
Ottawa, Canada

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ABSTRACT

The last two to three years have produced rapid changes in the way uranium tailings are managed in Canada. This is due both to the development of new technology and changes in regulatory approach. The thrust of this paper will be to clarify the interrelationships between these two areas with a particular focus on long-term management. The interaction between federal and provincial agencies will also be reviewed to illustrate how a co-operative regulatory approach works, even in areas of complex and sometimes confusing jurisdiction.

RÉSUMÉ

Les deux ou trois dernières années ont donné lieu à de nombreux changements dans le domaine de la gestion des résidus de traitement d'uranium au Canada. Ceci est dû au développement d'une nouvelle technologie et aux changements dans l'approche de la réglementation. Le présent article aura donc comme objectif de définir l'interdépendance qui existe entre ces deux secteurs, en insistant principalement sur la question de gestion à long terme. Les relations entre les agences gouvernementales fédérales et provinciales seront aussi abordées afin d'illustrer le fonctionnement d'une approche coopérative de la réglementation, même dans les domaines de juridictions complexes et parfois équivoques.

RECENT DEVELOPMENTS IN THE REGULATION AND MANAGEMENT OF CANADIAN URANIUM TAILINGS

1. Introduction

In order to understand the recent developments, it is necessary to develop some perspective on the period prior to 1979. In this initial period approximately one hundred million tons of tailings were deposited in Canada. These tailings cover an area of approximately one thousand acres and are located mainly in the Elliot Lake area of Ontario and to a lesser extent in northern Saskatchewan and near Bancroft in southeastern Ontario. All of these tailings were placed into conventional surface containment structures with some minor back-filling operations also being conducted. During the 1950s and 1960s, the confinement structures used were predominantly natural topographic basins in combination with permeable embankments. During the expansion of the 1970s improved containment structures were built with an emphasis on impermeability and improved geotechnical engineering. As a result, it can generally be concluded that there is a high degree of confidence in our ability to physically contain the tailings within the storage areas. The primary focus in tailings management in the last few years has thus shifted towards a consideration of the long-term or close-out aspects of tailings management.

A second major component of tailings management in Canada has been the need for water treatment systems, particularly focusing on the removal of Radium 226. Such a need was first identified in the mid-1960s as a result of the elevation of radium and acidity levels in several of the major lakes near Elliot Lake. In response, the first systems were installed to treat effluents prior to their release to the environment. The treatment systems involved the addition of lime or limestone to elevate the pH and the addition of barium chloride to remove the Radium 226 in settling basins or small lakes. More recent examples of settling systems for the removal of Radium 226 have been exclusively oriented to engineered lagoons usually involving lined basins.

2. Technical Initiatives

Having briefly set out the status of uranium tailings management systems up to approximately 1979, it is appropriate to take a more detailed look at recent developments. These developments can loosely be grouped into placement technologies and environmental health and safety technologies.

2.1 Placement Technology

The new placement technologies attempt to address the ultimate disposal of the tailings as opposed to the storage of the tailings in conventional facilities. There are three new approaches to placement in Canada:

2.1.1 Dry Placement Method

The term dry placement usually refers to methods which result in tailings which are either unsaturated after they have been placed or to tailings which do not segregate into a sands and slimes fraction. The two principal methods currently being evaluated in Canada are coning or stacking techniques and the sub-aerial tailings placement technique. The coning and stacking technique is currently under detailed evaluation in the Elliot Lake area. One benefit to be achieved by this technique is the increase in storage capacity within an area for any given elevation of the external containment structures or embankments. Another

benefit is the possibility of developing a final surface contour which is much more suited to final close-out. A coning or stacking arrangement will usually seek to develop a topographic high or a continuous slope which is suited to shedding surface water rather than allowing it to infiltrate and appear as seepage. In Canada, net precipitation exceeds evapo-transpiration by up to fifty per cent and thus the control of surface water infiltration is an important aspect of long-term tailings management. While not all of the detailed technical results have been fully evaluated for these two techniques, the preliminary indications are very positive. Sufficient physical or geotechnical stability is being achieved with these placement techniques to provide the necessary integrity and confidence in this approach when applied on full scale.

The second major dry placement technique is the subaerial method which has not been used in Canada to date. The Key Lake Uranium Mining operation in northern Saskatchewan will be the first such application to uranium tailings. The principal benefits which are felt to be attributable to this approach are the high ultimate stability of the final tailings mass and the water shedding capability of the internally layered system. While all indications for such a system are very positive we should voice one cautionary note. In Canada, and particularly in northern Canada, we have a very severe winter climate. This means that for a period of approximately five months the laminar approach is not deemed to be practical due to freezing of the system. This means that moderately thick layers must be placed in a fairly conventional tailings deposition manner during the winter period. The effect of this discontinuity in the system is not well documented and remains an area for further study.

2.1.2 Pit Disposal

A relatively new disposal technology in Canada is the use of a mined out pit for the placement of the tailings. This technique is only now becoming a possibility for Gulf Minerals due to the availability of a mined out pit in the immediate proximity of a new ore body. It is visualized that the tailings generated from this new open pit will be placed into the mined out pit. In addition to the new tailings, it is currently proposed that the old tailings which are currently in a conventional land based tailings management facility will also be placed in the pit. Several interesting and novel approaches to this system of pit disposal have been suggested and are worth consideration here. The groundwater system in this region of northern Saskatchewan is normally very near to the surface which means that tailings placed in the pit will be below the groundwater table. Thus an important consideration for environmental and health protection is the interaction between the tailings and the groundwater system. Gulf is proposing a hydraulic barrier which utilizes a zone of very coarse waste rock placed between the pit wall and the tailings mass. This zone acts as a hydraulic short circuit in the system thus preventing any significant interactions between the groundwater and the tailings pore water. Furthermore the tailings will be deposited in a dry state, to limit the amount of pore water at the outset. Any seepage water will need to be collected and treated during some transition period. Once final equilibrium has been achieved the only interaction will be through diffusion processes across the coarse interface. The principal advantage to this approach is that the tailings will be placed in a truly inaccessible manner. Thus there will be much less need for land use controls. Radon emanation and gamma fields arising from the material will be extremely low as well.

2.1.3 Deep Lake Disposal

Canada as you know has many lakes in the Precambrian Shield. Considerable work has been undertaken during the last year to evaluate Quirke Lake in the Elliot Lake region as a possible disposal site for large amounts of tailings. Quirke Lake is approximately four hundred and fifty feet deep and current estimates would allow five hundred million tons of tailings to be deposited with one hundred feet of overlying water. The advantage of using such a system is that lakes in this setting are in a depositional environment. That is, in the long term, the tailings will be covered with lake sediments which will reduce the exchange of contaminants between the tailings mass and the overlying water. Offsetting this main benefit however are considerable technical uncertainties. There has never been in Canada nor in any other country a setting which is totally analogous to the Quirke Lake disposal site. Thus it is not clear precisely what the degree of interaction of various contaminants will be either during the short or long term. This interaction may be critical since the flow through the lake is roughly 4 000 L/s and water quality for downstream users needs to be protected. A preliminary review of current information has been completed and is serving as a base for future decisions.

2.2 Health and Environmental Aspects

A second major area involving new initiatives concerns the environmental and health protection aspects of uranium tailings management. This area also can be subdivided as follows:

2.2.1 Radium 226 in Effluents

Over the last several years several new technologies have been developed for Ra removal within Canada. The principal difficulty in operating a radium removal system is to insure adequate solid-liquid separation. Thus by fine tuning the process to optimize pH, flocculant addition and by the use of baffles to ensure that the full retention time is available, significant improvements have been achieved.

A second major approach to the solid-liquid separation problem has been the use of sand or multi-media filtration methods. Several examples are available within Canada at the present time. A major laboratory and pilot plant operation was conducted as a joint government and industry project to identify the most suitable methods for applying multi media filtration. The results of these studies show clearly that it is possible by using a well operated multi media filtration system to achieve levels of less than 0.3 Bq/L total radium in effluents from conventional uranium tailings operations. Another somewhat larger scale filter operation has been in use for effluent polishing after a conventional lagoon system and has been used primarily to eliminate peaks in radium which are attributable to high flows over loading the settling lagoons. This installation has also demonstrated satisfactory operation and has produced effluents of acceptable quality for direct discharge to the environment.

An important aside to the development of filtration techniques is the question of disposal of high specific activity backwash solutions. It was necessary to evaluate the viability of returning the backwash solutions directly to the tailings ponds since this represented the most realistic means of handling the material. The regulatory agencies in Canada have evaluated such methods on a general basis and, within limits imposed by a specific operation, have

decided that they are not fundamentally opposed to such practice. However, each applicant will have to verify that no unacceptable impacts will occur through such a practice.

During the period where these new technologies for radium removal were being developed the ICRP reevaluated the dosimetry of Radium 226 and concluded that the ALI for the material should be raised. This new primary standard by the ICRP leads to a drinking water standard in Canada of 1 Bq/L total Ra 226 as a maximum permissible concentration and a target level set at ten per cent of that. We thus have what appears to be a paradox in that there are treatment methodologies which can produce effluents from a tailings operation which may be higher in quality, with respect of Radium 226, than required by the maximum permissible drinking standard. This in turn has led to considerable confusion over effluent standards and water quality standards.

2.2.2 Ammonia in Effluents

Ammonia is a fairly serious environmental pollutant and is toxic to biota at very low concentrations particularly in situations where the pH level is in excess of 6.5 - 7.0. In addition, ammonia has been used extensively as a process reagent in uranium extraction facilities. In order to reduce environmental impact, magnesium hydroxide or hydrogen peroxide are increasingly used as a precipitating agent in place of ammonium hydroxide. Another approach would be to install an ammonium extraction facility and the conversion of that ammonia to ammonium nitrate for subsequent use as a fertilizer. If ammonia can be eliminated at the source through changes in the process, there will still be a small residue in the final effluent due to the blasting agents used in mining. This small amount of ammonia is probably unavoidable and in a practical sense is untreatable. The only solution therefore, appears to be to ensure that the pH level in the discharge and the assimilative capacity within the environment are adequate to allow for this small discharge of ammonia.

2.3 Economic Aspects

As a final component of our review of new developments up to the present date, it is necessary to look briefly at the economic situation facing the industry today. Several years ago yellowcake was selling for approximately fifty dollars a pound whereas today it is selling for something slightly less than twenty-five dollars a pound. Over the last two years considerable increases in the cost of production due to inflation have also occurred. Thus it is clear that the economic situation which the industry faces today and in particular the situation faced by producers of fairly low grade ore deposits has changed very dramatically. While environmental health and safety considerations do not normally impose a major economic burden upon the industry it would be naive for any regulatory agency to ignore this altered economic reality. This may become a particular issue when dealing with the long-term aspects. The technology and the possible solutions to some of the long term concerns may be more expensive than the short term operational solutions. Thus it is necessary that all regulatory agencies be cognizant of the impact of their actions on industry. In Canada we attempt to keep ourselves cognizant through dialogue with industry and by consulting them as part of the regulatory process. The details of this process will be discussed in the next part of the paper.

3. Regulatory Initiatives

In order to understand the new regulatory developments which have occurred in

Canada it is not only necessary to understand the technical developments which have already been discussed, but it is also necessary to understand the role of the public and the prevailing regulatory environment in Canada. This involves both federal and provincial authorities. As far as the public is concerned tailings management issues have assumed an extremely high profile in the last few years. In order to emphasize this, a brief review of some of the major public hearings and enquiries is illustrative. As part of the Elliot Lake expansion an environmental assessment board was established by Ontario which conducted hearings over a two year period. The main result of that review process was to conclude that the expansion could proceed without any unacceptable environmental or health risks. Another major enquiry referred to as the Bayda Commission took place in Saskatchewan. Its mandate was to determine whether there were any reasons why significant new development of uranium mining could not take place in Saskatchewan. It focused in part on the proposed Cluff Lake mining operation but addressed many moral, social and environmental issues general to the entire industry. Its conclusion was similar to the Elliot Lake review, in that, no unacceptable situations will develop where current technology is used and recommended that the industry proceed. Another major enquiry was the Bates Commission which took place in British Columbia. The final report of the Bates Commission again recommended that there was no particular reason to stop development. However, prior to the release of the final document the government of British Columbia decided to impose a seven year moratorium on exploration and development of uranium mining in the province. Again in the province of Newfoundland a public review process was held and its recommendation was that development of uranium mining not proceed until some final resolution of the long term aspects of tailings management be obtained. The government subsequently accepted the recommendation and there is effectively a moratorium on development in that province as well. Returning again to Ontario, the Ontario government set up a select committee of the provincial government to look at Hydro affairs. Part of that committee's review focused on the front end of the fuel cycle and made a number of recommendations affecting jurisdictional issues. The next major enquiry was the Key Lake Inquiry, again in Saskatchewan, which focused strictly on the development of the Key Lake mining operation and again concluded that there was no reason why that development could not proceed subject to specific conditions. The most recent set of public meetings has taken place in the Northwest Territories which as yet has no uranium development but has some potential properties which may be developed over the next decade. Finally, the province of Nova Scotia is establishing a uranium inquiry to look at all aspects of uranium exploration and development and in the meantime has imposed an exploration moratorium.

It should be very clear from this rather extended list how important public opinion has been in the formation of a number of major enquiries. In virtually all of these enquiries, tailings management, and in particular their long term aspects, have assumed a very prominent role. Another aspect of public concern is the provision of complete and accurate information. In virtually all instances in Canada, major initiatives such as development of new regulations, policies and the detailed review of submissions by proponents is now made available to the public who are invited to respond.

In order to understand the regulatory situation in Canada it is also necessary to understand the distribution of powers between the federal government and the various provincial governments. Section 109 of the British North America Act, the Act that created Canada, states that all lands, mines, minerals and royalties derived therefrom belong to the provinces. In 1946, using its power under Section 92.10(c) of the BNA Act to declare a "local work and

undertaking" to be for "the general good of Canada," the federal government passed The Atomic Energy Control Act.

Until the mid-1970's The Atomic Energy Control Act was used primarily to control the production and management of uranium products.[1] The policy of the Federal government was that, except in matters of national security and foreign policy, uranium mines should be subject to the same rules as those which the provinces exercise over other mines.[2] Environmental aspects of uranium mining were controlled by the provinces in a similar manner to environmental control of all mines, which admittedly was not overly adequate.

In the 1970's much more emphasis was being placed on protection of the Canadian environment. Both the Atomic Energy Control Board and the provincial environment departments began exercising much tighter control over the environmental effects of the uranium industry.

3.1 Saskatchewan Requirements

It is the policy of the Government of Saskatchewan to exercise firm control over the environmental and health aspects of resource developments. It is also the policy of the Province to do this with a fully co-operative and consultative approach with the Atomic Energy Control Board and other Federal agencies.

In Saskatchewan a number of companies began development of new uranium ore bodies in the 1970's. Gulf Minerals began operating the Rabbit Lake Mine in 1974. Amok Limited submitted the Environmental Impact Statement for the project near Cluff Lake in November, 1976. As well, projects at Key Lake, Midwest Lake, Collins Bay, Dawn Lake and Candy Lake were on the horizon.

In view of the potential for significant uranium development in Saskatchewan, with its potential for environmental and social impact, and in view of growing public opposition to the developments, the Government of Saskatchewan set up the "Cluff Lake Board of Inquiry" under Justice E.D. Bayda in February, 1977. The terms of reference of the inquiry were very broad. The committee was asked to conduct a public inquiry into the probable environmental, health, safety, social and economic effects of the Cluff Lake mine, as well as the social, economic and other implications of the expansion of the uranium industry in Saskatchewan.

On the general industry-wide issues and the jurisdictional questions Bayda recommended: a) the administration of regulations pertaining to pollution control in the mining industry be transferred from the Saskatchewan Mineral Resources to Saskatchewan Environment; b) Saskatchewan Environment require an environmental assessment process prior to approval of any new uranium mining operation; c) the province undertake to develop regulations and standards for the release of substances from uranium operations into the environment; d) regulations and requirements for mine site abandonment procedures be developed in greater detail; e) the granting of surface leases require compliance with these regulations; f) the governments in co-operation with companies carry out research and development of processes to reduce the release of radioactive materials from uranium mine sites; and g) the creation of an "Environmental Protection Fund" to finance monitoring and reclamation work after closure of the mine sites.

All of these recommendations were accepted by the government of Saskatchewan

and have since been implemented. Recommendation a) was accomplished by the creation of a Mines Pollution Control Branch within Saskatchewan Environment, and by means of two Orders-in-Council passed in January, 1980, which transferred jurisdiction. The transfer effectively separated the promotional aspects from the control function. Until new regulations are passed, environmental control of normal operations is accomplished by negotiating and issuing approvals to construct and operate under the Water Resources Management Act and the Air Pollution Control Act. The approvals include conditions respecting operations, investigations, effluent standards, monitoring requirements and abandonment requirements. The negotiations are conducted in close co-ordination with the Atomic Energy Control Board.

Measure b) has been provincial policy since the Bayda Inquiry, and is now formalized with the passing of the new Environmental Assessment Act. The regulations entitled "The Uranium Mining Environmental Control Regulations" have undergone an extensive public review and are now in the hands of the attorney general for legal revisions. The regulations cover the environmental control of uranium development from a detailed exploration stage, through construction, operation and through the abandonment-reclamation phase. The regulations include design and construction requirements, contingency procedures, reclamation and abandonment requirements, effluent quality standards, air quality standards, and monitoring requirements. The regulations increase the penalties for infractions by twenty-fold.

Measure d) has been implemented through the formal Environmental Assessment process and the new regulations.

Measure e) is being implemented for all new mining projects. Detailed surface lease agreements have been negotiated and signed for the Amok Limited and Key Lake projects. The surface lease for Key Lake was negotiated over a six month period resulting in an eighty (80) page lease agreement. The lease includes detailed agreements by the company to comply with all regulations, to meet set standards, to design, construct and operate the project such that the environment is protected and to decommission and abandon the property according to plans approved by the province.

The land and minerals in Saskatchewan are owned by the province. The minerals are developed under a mineral lease granted to companies. The lands are leased as described above so that the development may proceed. Upon depletion of the ore and close-out of the mine, the lands will eventually revert back to the ownership of the province. The provincial government desires to ensure that proper close-out procedures are implemented so that future generations in the province are not burdened with the cost of continued maintenance of the site without the benefits of the resource development. The surface lease agreements partially fulfil this desire. As well, a new "Environmental Protection Division" of the Heritage Fund has been initiated. The money for the fund has been initially derived from provincial royalties obtained from the uranium resource development. A move is now underway, as well, to have the companies contribute directly, according to production.

The government of Saskatchewan believes it is the full responsibility of the project proponent to properly reclaim the mine site so that the environment is protected over the long term. The province does, however, recognize that companies dissolve and that the province will eventually control the land. After a company has conducted the decommissioning procedures, a transition phase will be entered when the company and the regulatory agencies will

monitor to evaluate the reclamation procedures. The company will not be relieved of its responsibilities until this phase is over. Institutional control of the mine site lands will be implemented under the Provincial Lands Act. The future land use and future developments can be closely controlled by the Province under this Act.

Recommendation f) has been implemented with the establishment about one year ago of the "Mines Waste Research Secretariat" within Saskatchewan Environment. The Secretariat finances and furthers investigations into the mining waste management and stabilization. Initial concentration is being placed on some previously abandoned uranium mine tailings. The tailings sites are being used as full scale laboratories to investigate their effect and to study procedures to minimize this effect.

All of the environmental regulatory functions of the province of Saskatchewan are conducted in close association with the Federal agencies. There have not been any conflicts between one jurisdiction and another. Generally speaking, one agency may wish to impose a more stringent standard or rule than the other agency, but in such a case, the company must follow the more stringent rule.

In Saskatchewan, it is fortunate that the more stringent rules have been implemented prior to the major expansion of the industry and that the operations are mining a high grade ore so that economics allow them to implement the necessary sophisticated environmental control features.

3.2 Ontario Requirements

The Ontario Ministry of the Environment is proposing to introduce Surface Water Guidelines in addition to the Drinking Water Guidelines which were developed jointly with the Federal Government. The Surface Water Guidelines will present objectives for the concentration of radionuclides in surface water. These objectives will be numerically equivalent to the maximum acceptable concentrations of the radionuclides in drinking water. If there is more than one radionuclide in the surface water, then the combined effect of the radionuclides must be no greater than the effect of only one radionuclide present at its maximum acceptable concentration.

The MOE is also developing "Guidelines for the Discharge of Radionuclides to Surface Waters" whereby limits can be set to the concentrations of radionuclides in an effluent stream at its discharge point. These limits will be related to the MOE's surface water guidelines but will allow for a mixing zone between the point of discharge and the point where the surface water guidelines must be met. The guidelines will also propose a maximum permissible detriment to a drinking water supply as a result of the effluent. These draft effluent guidelines will soon be circulated to the affected industries and trade unions in Ontario with a request for their comments.

3.3 Federal Requirements

The Atomic Energy Control Board is the Federal agency which controls uranium mine tailings management facilities in Canada under the authority of the Atomic Energy Control Act. The main mechanisms for exercising this control are the application of regulations and the issuance of licences for each operating facility which specify detailed operating requirements. In order to develop these licences and to ensure that all issues are addressed, it is the policy of the Board to act as a coordinator for various other inputs. These inputs

are not only the inputs from the province but also from other federal government agencies. The Board uses as advisors departments such as the Department of the Environment to help in areas such as environmental review and the establishment of acceptable effluent release limits.

A major area of concern over the last year has been the development of a set of close out criteria initiated by the AECB in January, 1981. Since that time, meetings and public consultations have taken place and we can now summarize the substance of those comments. Industry in particular felt that the first draft lacked sufficient site specificity and expressed concern over the choice of performance objectives for radon emanation and gamma fields originating from the tailings. They also expressed concern over the possible costs of meeting the objectives and that there would be insufficient benefit gained. The comments received from the public at large were very limited and covered a fair spectrum of opinion from recommendations to cease future developments to general support for the initiative to develop criteria.

In response to the representations made, AECB staff have undertaken a reevaluation and a redrafting of the close out criteria and while the details are not as yet available for public distribution, certain general statements on new directions can be made. The thrust of the second draft will allow for more site specificity. In addition it is visualized that fewer performance oriented numbers will be included and that these will be replaced with some form of dose limitation. This latter implies that the role of pathways analysis and source term modelling will be increased. In effect,all operators will have to do a pathways analysis to determine a dose to individuals and groups and to determine what effect various remedial actions may have on that dose. Specific dose limits will be identified along with a de-minimis dose representing a level which can be neglected. The time frame implied in the criteria has been adjusted to focus on a period of approximately five years after operations cease. Thus when industry has met the criteria at the end of the five year period it may be allowed to return control over the closed out site to an appropriate regulatory agency. This agency would likely impose some form of longer term institutional control which is implicit in our approach to close-out. The methods we are looking at to manage the tailings in the long term may not prevent certain exposure situations such as the construction of dwellings on or very close to the tailings or the removal and mishandling of material in some other manner. The details relating to the dose limits for the criteria should be resolved in the very near future and we are hoping that the final set of close out criteria will be available for review by all interested parties by late spring which will allow for the final document to be released some time in the fall of 1982.

In addition to the technical requirements of the close out criteria, we are also engaged in reviewing various financial guarantee mechanisms which will assist all government departments and agencies in carrying out their assigned responsibilities. The close out criteria focus on an initial five year period in part to facilitate the definition of financial guarantees. Thus it should be possible to develop fairly simple and fairly straight forward mechanisms whereby assurance is provided that an operator completes the initial close out work to a standard which is compatible with the close out criteria irrespective of his financial circumstances at the time of close out. The question of financial guarantees beyond the five year period is rather more difficult to define and is currently subject to detailed negotiations between the federal and provincial governments as well as industry itself.

4. Technical-Regulatory Interaction

At this stage it is interesting to ask how well the regulatory process works or for that matter how it works in some level of detail. Another form of this question is to ask whether technology leads the regulatory process or whether the regulatory process is pushing technology. As you can see from the above discussion there is a third component which is often ignored and that is public involvement and perception. Considering the unique approach to regulations which exists in Canada, that is, the consultative approach, the resolution of this question is not at all clear cut. Technology, regulations and public perception are clearly linked. The maximum separation between progress in any one of the three fields is severely limited. It is limited in part because research cannot and is not done without some understanding of the objectives which that research is aiming to achieve. In the regulatory field this may be a performance oriented objective relating to close out. It may be the stated goal of a regulatory agency to separate undesirable contaminants from a large mass of essentially clean material or it may represent a new technical breakthrough in the process of uranium extraction which prevents the release of undesirable contaminants.

Furthermore it may be related to a new public outcry or a new public awareness which demands a more thorough or a more rigorous approach to the entire regulatory process. An obvious example here is the long term aspects of tailings management which have received impetus in the last few years.

An example of how all of these various issues have to be fitted together could be given with reference to the Quirke Lake disposal study which was previously mentioned. Some sectors of the public are clearly in favour of this approach even though they have not yet been apprised fully of the technical issues that surround the use of Quirke Lake as a disposal site. This same public group is opposed to further expansion of conventional on-land uranium disposal facilities which in most cases will involve the loss of small lakes in the same general area as Quirke Lake. From a regulatory point of view, the issues are equally complex. The use of a lake for the deposition of tailings is not considered normal practice in Canada and in some quarters is not regarded as the most desirable general approach to the problem. It is however recognized that, in particular circumstances, it may be desirable and preferential to utilize such an option. Thus the implication for most regulatory agencies is that the use of a deep lake may involve modifications to prevailing regulatory policies. Modifications of regulations has not been a common procedure in Canada and as such carries with it a considerable amount of inertia which may delay the overall approval process. Another aspect of concern to the regulatory agencies is the question of novelty. Novel technology carries with it a certain element of uncertainty -- a certain element of risk. It is thus impossible to say with complete assurance that a proposed new approach will work as designed or as predicted. The question may arise if a system should fail to perform in the proper way as to who is responsible for undertaking the necessary remedial action - industry or the regulatory agencies themselves or a combination of the two. Historically it has been the position in Canada that even when a regulatory agency grants approval it does not absolve the proponent from responsibility for deficiencies in the system for whatever reason. This constraint however is a very serious and very sobering one from the point of view of industry and tends to make industry cautious in its application of new and unproven technologies. Turning then to the technical aspects of disposal of tailings into a deep lake, we immediately are confronted with a wide range of uncertainties. The mechanisms which will control such a system after

operations have ceased are not well understood. The movement of contaminants across the tailings water interface, the mechanisms which may exist within the ecosystem which would remove contaminants from the water column and redeposit them in the sediment are not well documented. In addition, the rate at which these phenomena will change with time over the next several hundreds of years is also unclear. The net effect of all of this uncertainty is to make even the most dedicated advocate of such a system pause to reflect.

From the above discussion it is clear that for disposal into a deep lake no single aspect (technology, regulations or public opinion) can be taken in isolation. Complete openness and consultation is mandatory. Fortunately this process of consultation has been ongoing as the normal mode of operation in the Canadian regulatory environment. There are critics of such an approach who claim that its effectiveness is limited, that it allows the biases of various parties too much credence, and that it is inherently slow and cumbersome. We in Canada feel however that the benefits of such a system far outweigh any possible liabilities. We will continue to pursue our approach to consultation and we will also continue to set general criteria which allow industry the freedom to implement measures in an innovative and cost effective manner. We will furthermore continue to refine our standards when it is appropriate to do so given newer, better and less costly technology. We will also continue to consider on a case-by-case basis the need to retrofit new technology into existing operations. It has not been our policy to universally retrofit a new technology and in fact generally speaking new technology has not been retrofitted to existing operations. In order to justify such a retrofit one would have to be able to demonstrate a strong need to improve the current situation and also be able to show that such a retrofit represents a reasonably effective use of available resources. Finally, we will strongly resist the urge to allow the regulatory process to become dominated by any one approach or by any one group. We will endeavour to continue to take that difficult middle road which seeks to balance complex and sometimes conflicting requirements in a manner which offers the greatest collective benefit to all of the people of Canada.

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